follows an investigation of collineation in a plane, comprising perspective transformations, and the linear transformations of translation, rotation, and dilatation, with combinations of these. The intimate relation that exists between projective and descriptive geometry is shown. The third chapter gives the general theory of conics, the projective properties of the circle being extended to conics by perspective transformations. The next chapter deals with pencils and ranges of conics and their products, and especially with cubics, the latter being classified under the five standard types by the help of the Steinerian transformation. Throughout the book analytical and geometrical methods are employed side by side, some portions of the subject being better suited to the former treatment; moreover, the analysis affords excellent illustrations of modern analytical geometry. The main purpose of the author has been to develop the subject in regard to its practical applications in mechanics, and the last chapter is devoted to such examples. Thus we find problems in graphic statics, plane stresses, and in the stress ellipse of an elastic material, and there is an interesting account of various linkages by means of which linear and perspective transformations can be mechanically obtained. The book is excellently got up in every way, and the diagrams are quite perfect and may well serve as models of what such figures ought to be. The author is a very clever draughtsman, and his skill as a writer is equally pronounced.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Fictitious Problems in Mathematics.

IN my younger days it was well recognised that such statements as "perfectly smooth" and the like were mere conventional phrases for designating an ideal state of matter, which was assumed to exist for the purpose of simplifying the mathematical conditions as far as possible. Nobody can learn mathematics without working out a large number of problems and examples, and in order to make these sufficiently easy for the beginner, various fictitious hypotheses have to be introduced.

Similar objections would apply to the phrase "frictionless liquid"; but it would be impossible for anyone to learn hydrodynamics without first studying the mathematical theory of this fictitious form of matter. In fact, the introduction of viscosity leads to such formidable difficulties, that nobody has yet succeeded in solving such a simple problem as the motion due to a doublet situated at the centre of a sphere; and the solution, if it could be obtained, would throw much light on the mode of attacking more difficult problems. A. B. BASSET.

May 28.

IN NATURE of May 18 the wording of a problem set near the beginning of my "Rigid Dynamics" is rather adversely commented on. In the problem a man is described as walking along a perfectly rough board which rests on a smooth table, and the criticism is that the two suppositions are inconsistent; but this depends on what is meant by the words used, and perhaps I may be allowed to make an explanation.

When bodies are said to be perfectly rough, it is usually meant that they are so rough that the amount of friction necessary to prevent sliding in the given circumstances can certainly be called into play. In art. 156 of the treatise on dynamics, just after the laws of friction have been discussed, the words "perfectly rough" are defined to have this meaning. The board in question has therefore no special peculiarity. All that is stated is that the coefficient of friction between the man and the board exceeds a certain finite quantity.

The board rests on a smooth table, but the coefficient of friction now depends on both the board and the table, and this may be quite different from that between the man and the board. There is nothing amiss in supposing this coefficient to be zero. One way of effecting this experimentally would be to polish the table and remove all roughnesses from it. This was the plan indicated.

Where, then, is the inconsistency?

By using the ordinary abbreviations of language, the wording of the question has been made concise, and thus attention was specially directed to the dynamical principle involved in the solution.

The problem has been understood by so many students in the sense above described, and worked without a single objection having been raised, that I think the meaning must be perfectly clear. Indeed, I cannot imagine what other meaning it could have. E. J. ROUTH.

May 20.

On the Spontaneous Action of Radio-active Bodies on Gelatin Media.

IN the course of some experiments on the formation of unstable molecular aggregates, notably in phosphorescent bodies, I was led to try whether such dynamically unstable groupings could be produced by the action of radium upon certain organic substances. It will scarcely be necessary to enter here into an account of the many speculative experiments which I have at one time or another tried, but it will suffice if I describe, as briefly as possible, the experiment which, amongst others, has led to a very curious result, and that is the effect of radium chloride and radium bromide upon gelatin media, such as those generally used for bacterial cultures.

An extract of meat of 1 lb. of beef to 1 litre of water, together with 1 per cent. of Witter peptone, 1 per cent. of sodium chloride, and 10 per cent. of gold labelled gelatin, was slowly heated in the usual way, sterilised, and then cooled. The gelatin culture medium thus prepared, and commonly known as bouillon, is acted upon by radium salts and some other slightly radio-active bodies in a most remarkable manner.

In one experiment the salt was placed in a small hermetically sealed tube, one end of which was drawn out to a fine point, so that it could be easily broken. This was inserted in a test-tube containing the gelatin medium. The latter was stopped up with cotton wool in the usual way with such experiments, and then sterilised at a temperature of about 130° C. under pressure for about thirty minutes. Controls without radium were also at various times thus similarly sterilised.

When the gelatin had stood for some time and become settled, the fine end of the tube containing the radium salt was broken, from outside, without opening the test-tube, by means of a wire hook in a side tube.

The salt, which in this particular experiment consisted of $2\frac{1}{2}$ milligrams of radium bromide, was thus allowed to drop upon the surface of the gelatin.

After twenty-four hours or so in the case of the bromide, and about three or four days in that of the chloride, a peculiar culture-like growth appeared on the surface, and gradually made its way downwards, until after a fortnight, in some cases, it had grown fully a centimetre beneath the surface.

If the medium was sterilised several times before the radium was dropped on it, so that its colour was altered, probably by the inversion of the sugar, the growth was greatly retarded, and was confined chiefly to the surface.

It was found that plane polarised light, when transmitted through the tube at right angles to its axis, was rotated left-handedly in that part of the gelatin containing the growth, and in that part alone.

The controls showed no contamination whatever, and no rotation. The test-tubes were opened and microscopic slides examined under a twelfth power. They presented the appearance shown in Fig. 1. At first sight these seemed to be microbes, but as they did not give sub-cultures when inoculated in fresh media they could scarcely be bacteria. The progress of any of the sub-cultures after a month was extremely small, and certainly

too small for a bacterial growth. It was not at all obvious how bacteria could have remained in one set of tubes and not in the other, unless the radium salt itself acted as a shield, so to speak, for any spores which may originally have become mixed with the salt, perhaps during its manufacture, and when embedded in it could resist even the severe process of sterilisation to which it was submitted.

On heating the culture and re-sterilising the medium, the bacterial-like forms completely disappeared; but only temporarily, for after some days they were again visible when examined in a microscopic slide. Nay, more, they disappeared in the slides when these were exposed to diffused daylight for some hours, but reappeared again after a few days when kept in the dark. Thus it seems quite conclusive that whatever they may be, their presence is at any rate due to the spontaneous action of the radium salt upon the culture medium, and not alone to the influence of anything which previously existed therein.

When washed they are found to be soluble in warm water, and however much they may resemble microbes,

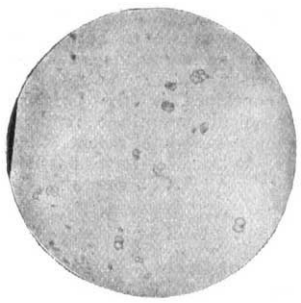


FIG. 1.

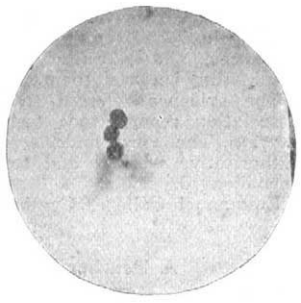
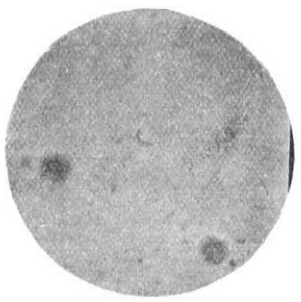


FIG. 2.



they cannot for this reason be identified with them, as also for the fact that they do not give subcultures as bacteria should.

Prof. Sims Woodhead has very kindly opened some of the test-tubes and examined them from the bacteriological point of view. His observations fully confirm my own. He assures me that they are not bacteria, and suggests that they might possibly be crystals. They are, at any rate, not contaminations.

I have tried to identify them with many crystalline bodies, and the nearest approximation to this form appears to be that of the crystals of calcium carbonate, but these are many times larger, and, in fact, of a different order of magnitude altogether, being visible under comparatively low powers; and are, moreover, insoluble in water.

A careful and prolonged examination of their structure, behaviour, and development leaves little doubt in my mind that they are highly organised bodies, although not bacteria.

Unfortunately the quantity is so very minute that a chemical analysis of their composition is extremely difficult. The amount of salt in the first instance is so small, and the number of aggregates, or whatever they may be, thus produced perhaps still smaller.

The most effective method of studying their properties, from the physicist's point of view, is that of long and, so far as possible, continual observation, a method similar to that which the astronomer is bound to adopt in his study of bodies over which he has not the control to deal with as he pleases.

From the accompanying photographs it will be observed that they are not all of the same size; they range from about 0·3 μ to the minutest specks; they are mostly, if not altogether, all of the same shape, and show distinct signs of growth; the larger ones appear to have sprung from smaller forms, and these in turn from still smaller ones, and they have all probably arisen in some way from the invisible particles of radium.

Fig. 2 distinctly shows the existence of nuclei in the larger and more highly developed forms, whilst Fig. 3 reveals, though indistinctly, what is their most remarkable property of all, and that is their subdivision when a certain size is reached. They do not grow beyond this size, but subdivide.

These photographs, together with the numerous results of eye observations, which indicate that a continuous growth and development take place, followed by segregation, leave little doubt that whilst on the one hand they cannot be said to be bacteria, they cannot be regarded as crystals either in the sense of being merely aggregates of symmetrically arranged groups of molecules, which crystals are supposed to be. The stoppage of growth at a particular stage of development is a clear indication of a continuous adjustment of internal to external relations, and thus suggests vitality.

They are clearly something more than mere aggregates in so far as they are not merely capable of growth, but also of subdivision, possibly of reproduction, and certainly of decay.

The subcultures do show, however slightly, some indication of growth after four or five weeks, although that growth is, I understand, too small for a bacterial subculture. Moreover, when examined in the polariscope they have not been found to yield the characteristic figures and changes of colour which crystals generally give.

Thus for these reasons I have been led to regard them as colloidal rather than as crystalline bodies, and probably more of the nature of "dynamical aggregates" than of "static aggregates," of which crystals are composed.

There appears to be a tendency amongst text-book writers to classify minute bodies which are not bacteria as crystals, but really without sufficient reason, and as these bodies cannot be identified with microbes, on the one hand, nor with crystals on the other, I have ventured, for convenience, in order to distinguish them from either of these, to give them a new name, *Radiobes*, which might, on the whole, be more appropriate as indicating their resemblance to microbes, as well as their distinct nature and origin.

Some slightly radio-active bodies appear also to produce these effects after many weeks.

A more detailed account of these experiments will be published shortly. This note merely contains some of the principal points so far observed.

I have to thank Mr. W. Mitchell, who sterilised the tubes, for the assistance he has rendered in these experiments.

JOHN BUTLER BURKE.

Cavendish Laboratory, Cambridge, May 10.

The Consolidation of the Earth.

THERE are several points in Dr. See's last letter (NATURE, May 11) calling for remark from the geological point of view.

(1) The effect of (hydrostatic) pressure at depths tends not to liquefaction (as in the case of the ice of a glacier) but to promote crystallisation, the condition of the greatest density of mineral matter, as I showed years ago in my little work on metamorphism in discussing the relation of the crystalline to the vitreous states. It is here that the importance of "solid-liquid critical state" comes in.

(2) We have no right to assume the existence at any stage of the history of our planet of a mere molten ball radiating heat directly into cold space, since in that "pre-oceanic stage" it was surrounded by a non-conduct-